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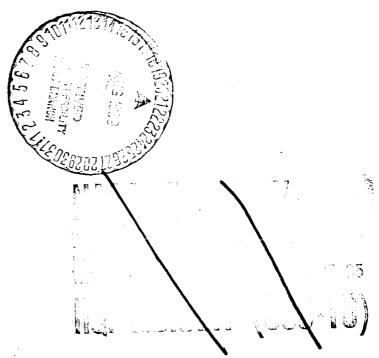
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SUBJECT: DEEDIX - A Program for Timeline Activities Analysis - Case 610

DATE: January 17, 1969

FROM: D. P. Nash

ABSTRACT

The DEEDIX program was written to automate the extensive calculations required for a consumables analysis of a mission activity timeline. It is an effective method of determining if the rates and total consumption of expendables remain within the constraints set by crewmen and spacecraft capabilities. The output of the program displays expendable consumptions resulting from the execution of activities by crewmen and machine processors as a function of time. For input, DEEDIX requires time and activity data from a mission timeline.

B69 03042

MEMORANDUM FOR FILE

I.   INTRODUCTION

The DEEDIX program was written to automate the extensive computations required for a consumables analysis of a mission timeline. DEEDIX requires as input data (1) a timeline of activities performed by crewmen or other processors during a mission and (2) specified consumption rates of expendables for each scheduled activity. The program's output displays the total consumption of each expendable as a function of time. Although activity processors other than crewmen are permissible, the following discussion will, for explicitness, refer to crewmen only.

II.   PROGRAM OUTLINE

A flow diagram of DEEDIX is shown in Figure 1; Appendix indicates the arrangement of a typical data deck. Initially, an ascending series of time values is read for each crewman, every value being associated with a change of the crewman's activities. These values are strung into one inclusive series, $A(J)$, which is arranged into ascending order by the program. Next, the corresponding activity sequence for each crewman is read in and is correlated with the time values to reconstruct his activity timeline. An activity sequence is a chain of integers, each integer having been assigned by the user to designate a particular activity.

Each activity is defined by the rates at which particular expendables are consumed. Examples of expendables are oxygen, nitrogen, water, and electrical power. The primary objective of the program is to determine the total rate of consumption and the cumulative consumption of each expendable as a function of mission time. This information is used to determine whether the rates and totals of consumption remain within a permissible range delimited by the capabilities of the spacecraft systems and of the crewmen. To determine the values of expenditure, the following procedure is used:

1.   Array $Q(J,I)$ is derived. This array shows the activity of each crewman (I) during every interval of time (J) of the inclusive series $A(J)$.

2.   Array $P(L,M)$ is read as input. It lists the consumption rate of expendable (M) by activity (L).

3. Four nested iteration loops (DO loops) are introduced:

   a. The outside loop iterates the intervals of the inclusive time sequence A(J).

   b. The second loop iterates the number of crewmen and other processors.

   c. The third loop iterates the numbers representing the activities. It tests to find the numbers corresponding to the entries in array Q(J,I) for the crewmen (I) and the interval (J).

   d. The innermost loop iterates the number of expendables. The respective consumption rates of each expendable by all crewmen are added to obtain the total rates, TOTALR, of consumption per interval. The total rate for each expendable is multiplied by the duration of the interval to determine the total consumption, TOTALS, of each expendable within the interval. Finally, this last derived value is added to the preceding cumulative consumption of the expendable to determine the present cumulative consumption, ACUCON.

   This process is repeated for each succeeding time interval.

   When more than one crewman is required for implementation of an experiment, the entire expendable consumption is attributed to one man. This method is used because total consumption values are obtained by summing across the crewmen.

   DEEDIX has been successfully tested using a four day segment of AAP-1/AAP-2 mission timeline.* Variables utilized include 3 crewmen, 12 activities, and 2 expendables. Computer time necessary for one run was seven seconds.

   The program can easily be expanded beyond its present capabilities of 3 processors, 25 activities, and 5 expendables by increases in the number of assigned values given for the variables in the DIMENSION statement. The only major modifications necessary for any run, other than that carried out by the author, are to the output formats, for example, activity reference numbers and expendable identifications. Appendix B shows that the tabular output of the present program is labeled to deal specifically with the expendables oxygen and electrical power.

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*D. J. Belz, "Experiment Scheduling for the AAP-1/AAP-2 Mission" Case 610, Memorandum for File, December 11, 1968.

III. PROSPECTUS

For greater program flexibility, the writer is devising a routine which will graphically display the output of the present program.

With only slight changes to input data and format, the program may be used to keep track of each crewman's location within the spacecraft as a function of time. By regarding the crewmen as moving sources of CO_2 and heat, such timelines may assist ECS (Environmental Control System) and thermal design.

IV. ACKNOWLEDGMENTS

The author expresses appreciation to Messrs. A. B. Baker and D. J. Belz for their guidance in the preparation of DEEDIX.

D. P. Nash

1025-DPN-dcs

Attachments

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APPENDIX A

DATA DECK ARRANGEMENT

DATA 1 (1 Card)

   Format: I3   Number of processors.

DATA 2 (1 Card)

   Format: I5   Number of instants in timeline
                                      of processor 1.

DATA 3 (1 or more cards)

   Format: 10F7.3   Time sequence of processor 1. Time
                                        is entered in hours.minutes format.

DATA 4 (1 or more cards)

   Format: 14I5   Sequence of activities performed by
                                      processor 1.

INFORMATION SUCH AS THAT GIVEN IN DATA 2, 3, AND 4 IS REPEATED FOR EACH PROCESSOR.

DATA 5 (1 Card)   Number of activities, number of
                                      expendables.

DATA 6 (number of card units equals number of activities)

   Format: KF6.3   (K is the number of expendables.)
                                      Rates of consumption of expendables.

APPENDIX B - OUTPUT CONFIGURATION

MISSION TIME (HOURS.MIN)	DURATION OF INTERVAL (HOURS)	CHARACTERISTIC	TOTAL RATE OF CONSUMPTION	TOTAL CONSUMPTION PER INTERVAL	CUMMULATIVE CONSUMPTION
417.30	1.2500	POWER	.0000 KW	.0000 KWH	.0000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
418.45	.2500	POWER	.0000 KW	.0000 KWH	.0000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
419.00	1.0000	POWER	.2000 KW	.2000 KWH	.2000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
420.00	.2500	POWER	.0000 KW	.0000 KWH	.2000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
420.15	1.3333	POWER	.0000 KW	.0000 KWH	.2000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
421.35	.5000	POWER	.2000 KW	.1000 KWH	.3000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
422.05	.4167	POWER	.0000 KW	.0000 KWH	.3000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
422.30	1.3333	POWER	.0000 KW	.0000 KWH	.3000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS
423.50	.9167	POWER	.0000 KW	.0000 KWH	.3000 KWH
		OXYGEN	.0000 LBS/HR	.0000 LBS	.0000 LBS

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APPENDIX C

FORTRAN DICTIONARY

FORTRAN NAME	UNITS	DESCRIPTION
A(I)	HOURS.MIN	TIME SEQUENCE WHICH INCORPORATES TIME SERIES OF ALL PROCESSORS.
ACT		ACTIVITY REFERENCE NUMBER -- INTEGER.
ACUCON		CUMULATIVE CONSUMPTION OF AN EXPENDABLE.
FLIP	HOURS.MIN	DURATION OF INTERVAL BETWEEN ANY TWO CONSECUTIVE VALUES ON A TIME-LINE.
IBO		TOTAL NUMBER OF ACTIVITIES.
INSTAN(J)		TOTAL NUMBER OF INSTANTS ON TIMELINE OF PROCESSOR (J).
JUMP		TOTAL NUMBER OF INSTANTS OF TIME ON INCLUSIVE TIMELINE A(I).
JUMP1		JUMP - 1
KIK		KIX - 1
KIX		TOTAL NUMBER OF INSTANTS OF TIME IN INCLUSIVE SERIES A(I) BEFORE IDENTICAL INSTANTS REMOVED.
LOR		TOTAL NUMBER OF EXPENDABLES.
MINUS(J)		INSTAN - 1; TOTAL NUMBER OF INTERVALS ON TIMELINE OF PROCESSOR (J).
NUMBER		NUMBER OF PROCESSORS.
P(L,M)		ARRAY CONTAINING EXPENDABLE CONSUMPTION RATES (M) PER ACTIVITY (L).

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FORTRAN NAME	UNITS	DESCRIPTION
Q(J,I)		ARRAY CONTAINING ACTIVITY NUMBER OF EACH PROCESSOR (I) IN EACH INTERVAL OF TIME (J) OF SERIES A -- INTEGER.
TOTALR		TOTAL CONSUMPTION RATE OF AN EXPENDABLE IN AN INTERVAL OF TIME.
TOTALS		TOTAL CONSUMPTION OF AN EXPENDABLE IN AN INTERVAL OF TIME.
TRATE		SAME AS TOTALR; INCLUDED FOR FUTURE PLOTTING PURPOSES.
TSUM		SAME AS TOTALS; INCLUDED FOR FUTURE PLOTTING PURPOSES.
W(J)		DURATION OF jth INTERVAL OF A(J).

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┌─────────────────────────────┐
│ READ INDIVIDUAL TIME SERIES │
│ INPUTS AND INCORPORATE INTO │
│ ONE INCLUSIVE TIMELINE      │
└─────────────────────────────┘
              │
              ▼
┌──────────────────────────────────┐
│ READ INDIVIDUAL ACTIVITY SERIES INPUTS │
└──────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ WRITE FOR EACH CREWMAN AN INDIVIDUAL │
│ TABLE LISTING MISSION TIME, ACTIVITY │
│ PERFORMED AT THAT TIME, AND DURATION │
│ OF INTERVAL                          │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ ARRANGE INCLUSIVE SERIES IN ASCENDING │
│ ORDER, AND DETERMINE THE DURATION OF  │
│ EACH INTERVAL BETWEEN THE CONSECUTIVE │
│ TIME VALUES OF THE SERIES             │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ DERIVE ARRAY Q(J,I) SHOWING │
│ ACTIVITY OF EACH CREWMAN (I) │
│ DURING EACH INTERVAL OF TIME │
│ (J) OF THE INCLUSIVE SERIES  │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ READ INPUT ARRAY P(L,M) LISTING │
│ RATE OF CONSUMPTION OF EACH      │
│ EXPENDABLE BY EACH ACTIVITY (L)  │
└─────────────────────────────────┘
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DO   J = 1, JUMP1

DO   I = 1, NUMBER

DO   L = 1, IBO

NO ◄── IF Q(J,I) = L

YES

DO   M = 1, LOR

TOTALR(M) = TOTALR(M) + P(L,M)

S(M) = P(L,M) * W(J); CONSUMPTION OF
CHARACTERISTIC M = RATE OF CONSUMPTION
*LENGTH OF INTERVAL

TOTALS(M) = TOTALS(M) + S(M)

DO   M = 1, LOR

ACUCON(M) = ACUCON(M) + TOTALS (M)

WRITE OUTPUT: MISSION TIME, LENGTH
OF INTERVAL,, TOTAL RATE OF CONSUMPTION,
TOTAL CONSUMPTION WITHIN INTERVAL,
CUMULATIVE CONSUMPTION

TOTALR(M)=0.0
TOTALS(M)=0.0

SEE APPENDIX C (FORTRAN DICTIONARY) FOR DEFINITION OF FORTRAN
VARIABLES.

FIGURE 1 FLOW DIAGRAM OF DEEDIX